CLAIMS

What is claimed:

1. A communication system comprising:

a first transceiver located with a first user having a first processor and a first directional antenna array;

a second transceiver located with a second user having a second processor and a second antenna array;

a locator on at least one of the first user and second user that determines a physical location of one of the first and second antenna array;

a spatially multiplexed communication link formed between the first and second transceivers, and

an adaptive programmable beamformer circuit in the first transceiver that shapes a communication beam directed between the first antenna array and the second antenna array, the adaptive programmable beamformer circuit having a single integrated chip having a plurality of complex multipliers, a plurality of down conversion circuits and a plurality of finite impulse response (FIR) filters programmable with respect to a plurality of delays and a steering circuit that adjusts the plurality of delays to the programmable beamformer circuit.

2. The system of Claim 1 wherein the first and second antenna arrays are movable relative to one another and the programmable beamformer updates the direction of the communication beam in response to the relative motion.

3. The system of Claim 1 wherein the communication beam is a radio frequency beam.

4. The system of Claim 1 wherein the locator is responsive to location data from a satellite positioning system.

5. The system of Claim 1 wherein the locator is responsive to location data from a ground-based positioning system.

6. The system of Claim 1 wherein the beamformer includes a nulling circuit for suppressing signals outside of the direction of the second antenna array.

7. The system of Claim 1 wherein the beamformer includes an adaptive processing module to alter the shape of the communication beam over time.

8. An acoustic communication system comprising:

a first transceiver having a directional antenna array, the directional antenna array having a first geographical position;

a second transceiver on a mobile unit having an antenna array, the antenna array being movable relative to the directional antenna array;

a spatially multiplexed communication link between the first and second transceivers formed by a communication signal between the antenna arrays;

a positioning system on the mobile unit that detects a geographical position of the mobile antenna arrays, the position of the mobile antenna array being communicated from the mobile transceiver to the first transceiver over the communication link;

an adaptive programmable beamformer circuit in the first transceiver that modifies the signal in response to the relative motion of the antenna arrays, the adaptive programmable beamformer circuit having a single integrated chip having a plurality of complex multipliers, a plurality of down conversion circuits and a plurality of finite impulse response (FIR) filters programmable with respect to a plurality of weights and a steering circuit that adjusts the plurality of weights to the programmable beamformer circuit; and

a nulling module coupled to the beamformer that suppresses interference to the signal.

9. The system of Claim 8 wherein the beamformer updates the shape of the signal over time.

10. The system of Claim 8 wherein the signal is a radio frequency beam.

11. The system of Claim 8 wherein the positioning system is responsive to position data from a satellite positioning system.

12. The system of Claim 8 wherein the positioning system is responsive to position data from a ground-based positioning system.

13. The system of Claim 8 wherein the beamformer includes a plurality of programmable filter arrays.

14. The system of Claim 8 further comprising a table of stored antenna weights stored in memory, the table accessed by the nulling module to modify the signal.

15. The system of Claim 8 further comprising an adaptive processing module to alter the shape of the beam over time.

16. The system of Claim 8 wherein the mobile antenna array is a directional antenna array.

17. A method for operating an acoustic communication system comprising:

operating a first transceiver at a first unit and having a first processor and a first directional antenna array;

operating a second transceiver on a mobile unit having a second processor and a second antenna array;

determining the physical location of the second antenna array relative to the first antenna array;

forming a spatially multiplexed communication link between the first and second transceivers, the link including a communication beam between the first antenna array and the second antenna array; and

in an adaptive programmable beamformer integrated circuit chip in the first transceiver, responding to the physical location of the second antenna array, by using a plurality of complex multipliers, a plurality of down conversion circuits and shaping the communication beam using a plurality of programmable finite impulse response (FIR) filters with respect to a plurality of weights and steering the beam to be directed between the first antenna array and the second antenna array using the programmable beamformer circuit.

18. The method of Claim 17 further comprising the steps of:

moving the first and second antenna arrays relative to one another, and

in the beamformer, updating the direction of the signal over time in response to the relative movement.

19. The method of Claim 17 wherein the communication beam is a radio frequency beam.

20. The method of Claim 17 wherein the second transceiver in a mobile unit may function as the first transceiver and the first transceiver may function as the second transceiver.

21. The method of Claim 17 wherein the step of determining the physical position is responsive to position data from a satellite positioning system.

22. The method of Claim 17 wherein the step of determining the physical position is responsive to position data from a ground-based positioning system.

23. The method of Claim 17 wherein the beamformer includes a nulling circuit to suppress signals outside the direction of the second antenna array.

24. The method of Claim 17 wherein the beamformer includes an adaptive processing module for altering the shape of the communication beam over time.

25. A method of operating an acoustic communication system comprising:

operating a first transceiver having a first directional antenna, the first directional antenna having a fixed geographical position;

operating a mobile transceiver on a mobile unit having a second directional antenna, the second antenna being movable relative to the first directional antenna;

forming a spatially multiplexed communication link between the first and mobile transceivers by a communication signal between the antennas;

in a positioning system on the mobile unit, detecting the geographical position of the mobile antenna, the position of the mobile antenna being communicated to the first transceiver over the communication link; and

in a first adaptive programmable beamformer integrated circuit chip in the first transceiver and a second programmable beamformer integrated circuit chip in the mobile transceiver, modifying the signal in response to the relative motion of the antennas by using a plurality of complex multipliers, a plurality of down conversion circuits and shaping the communication signal using a plurality of finite impulse response (FIR) filters programmable with respect to a plurality of weights, and steering a beamformed signal.

26. The method of Claim 25 wherein the step of modifying the signal comprises updating the direction of the signal over time in response to the relative movement of the antennas.

27. The method of Claim 25 wherein the step of modifying comprises determining the range between the first antenna and the mobile antenna and, when the range is less than a specific range, modifying the signal to be omnidirectional.

28. The method of Claim 25 wherein the signal is a radio frequency beam.

29. The method of Claim 25 wherein the step of detecting comprises receiving position data from a satellite positioning system.

30. The method of Claim 25 wherein the step of detecting comprises receiving position data from a ground-based positioning system.

31. The method of Claim 25 wherein the beamformers include a plurality of programmable filter arrays.

32. The method of Claim 25 wherein the step of modifying the signal comprises providing antenna weights from a table stored in memory.

33. The method of Claim 25 wherein the step of modifying the signal comprises performing adaptive processing to alter the shape of the signal over time.

34. The method of Claim 25 wherein the step of modifying the signal comprises suppressing interference with the signal in a nulling module.

35. The method of Claim 25 wherein the step of forming the communication link comprises a spatially multiplexed signal.

36. A beamforming circuit for an acoustic communication system comprising:

a plurality of sampling circuits for receiving communication signals;

a plurality of programmable finite impulse response (FIR) filters, each FIR filter being connected to a sampling circuit;

a summing circuit that sums filtered signals from the plurality of FIR filters; and

a directional communication signal formed from the summed signals.

37. The circuit of Claim 36 wherein the sampling circuits, the plurality of programmable FIR filters and the summing circuit are formed on a single integrated circuit.

38. The circuit of Claim 36 further comprising a multiplier connected to each sampling circuit to generate an in-phase channel and a quadrature channel, each channel being connected to a filter, a converter and one of the FIR filters.

39. The circuit of Claim 36 wherein the communication system comprises an acoustic network including a plurality of transceivers that communicate by a communication link with mobile transceiver units, and further including a unit having an adaptive array processor providing weighting signals to the FIR filters.